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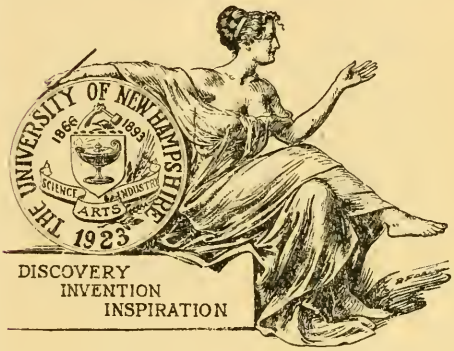

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Bulletin 203 January, 1922

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

REPORT

OF THE DIRECTOR OF THE

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1921

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

Durham, New Hampshire,
January 1, 1922.

Dr. R. D. Hetzel,
President of the New Hampshire College of Agriculture and the Mechanic Arts.

Dear Sir:

In accordance with the requirements of the Hatch Act of March 2, 1887, the Director of the State Agricultural Experiment Station is required to submit an annual report, on or before the first of February, of the work of the Station, including a statement of receipts and expenditures, to the governor of the state. I am herewith submitting such a report, for the fiscal year ending June 30, 1921.

Respectfully submitted,

J. C. KENDALL,
Director of Experiment Station.

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Report of the Director of the New Hampshire Agricultural Experiment Station for the Fiscal Year Ending June 30, 1921

In reviewing the work of the New Hampshire Agricultural Experiment Station for the past year, it may be worth while to point out that there are three fairly distinct lines along which the Station operates in the performance of its duties:

(1) It conducts original research investigations into the fundamental problems of agricultural science. The work done under the Adams Fund is specifically limited by Congressional appropriation to this field; and a number of long-time experiments are in progress, such as the studies in fruit bud formation, sheep breeding, etc. While the results of these can best be observed in perspective over a long period of years and are reported upon at length in separate bulletin-form, the annual developments in the projects are noted in the yearly reports.

(2) The Station investigates problems in their particular bearing upon New Hampshire conditions. This work includes the testing of varieties, breeding of new plants, studies in crop production, investigation of plant diseases and insect pests troublesome in the state, etc. It means the steady accumulation year by year of a fund of knowledge bearing upon New Hampshire agriculture which is available at all times to interested persons. Some of the Adams Fund work, in addition to its purely scientific value, is of exceptional interest on this account, and practically all of the Hatch Fund work falls into this category.

(3) The Station laboratories are used each year—and members of the Station staff employed—in such service work as the analyses of feeding-stuffs, fertilizers, and seeds, soil acidity tests and tests of blood samples of poultry for white diarrhea. In so far as possible, the attempt is made to keep this work self-supporting through revolving funds.

Along all these lines the development of the work during the past few years has been greatly hampered by the prevailing currency inflation which has practically had the effect of cutting in two the funds at the Station's disposal.

Happily at its most acute point the situation was somewhat relieved by the action of the Legislature in appropriating a special state fund for research work of $12,000.00 for the next biennium. While none of this fund was available until July 1, 1921, its assurance made possible the maintenance of all projects and the keeping of the staff fairly intact. This is the first recognition with state funds of the Experiment Station, and may well mark an epoch in the history of the institution, since in practically every other state in the country the Federal funds have for some time now been supplemented by state appropriations, thus making possible a greater volume

of research work and a correspondingly greater influence upon agricultural conditions. It takes time for the results of research work to make themselves felt in common practice; but these results are already visible to such an extent as to more than justify the development of the Experiment Station. See Station Bulletin 199, "Digging Up Facts for New Hampshire Farms," for a brief survey of some of the achievements.

The development of extension work in the state has had a direct bearing in a number of ways upon the experimental field. The extension demonstrations carry home points which have already been proved, and thus relieve the Station of some of the popularizing work which was formerly necessary. On the other hand, however, the demands upon the Station for specialized information are greatly increased; the calls for members of the Station staff to investigate farm problems and to give advice are multiplied; and the responsibility for leadership in the development of agricultural knowledge is greatly accentuated.

The situation is similar to that of a manufacturing concern which formerly handled all business by correspondence, but which later sent out agents who demonstrated and sold its wares in a wholesale fashion. This policy would inevitably react upon and change the conditions at the home office. The immediate contact between the factory and the consumer might become less, but the total volume of business would become much greater. The factory would have to enlarge to keep the supply up to the demand. The whole business would have to be administered with more scrupulous care and watchfulness; for an error would be multiplied many times. The necessity of foreseeing the trend of business and matching the supply of a given product with the probable future demand would be ever-present.

It is unfortunately true that the Experiment Station has not been able to grow to keep pace with the Extension Service. Shortly after the inauguration of the field agent policy, came the war and the currency inflation. The long-time experimental projects had to be maintained in the face of depreciating funds, and it has been possible only to keep the "home factory" going; there has been no opportunity to enlarge it to keep pace with new demands. This policy, if continued in, will be serious; for fundamentally the extension work rests upon the research work. As the former grows past its first stages, it will call more and more loudly for the solution of problems that have not been solved. It is the duty of the Experiment Station to maintain its natural leadership. It must not only keep faith with the purely scientific demands imposed upon it by the Adams Act, but it must forge ahead more rapidly than Federal funds will permit into those problems to which the extension agents of the next decade will need the answers.

Because of the close connection between the Experiment Station and the Extension Service it has been possible to use the same administrative office for both; and this has meant a more compact arrangement, with less overhead expense than would otherwise be possible. It also means that the growth of the two branches may be studied with a close eye to the mutual relationships; and this, as has been indicated, is likely to be more and more important.

In considering the projects pursued during the past year we will take up first those conducted under the Adams Fund, next those under the Hatch

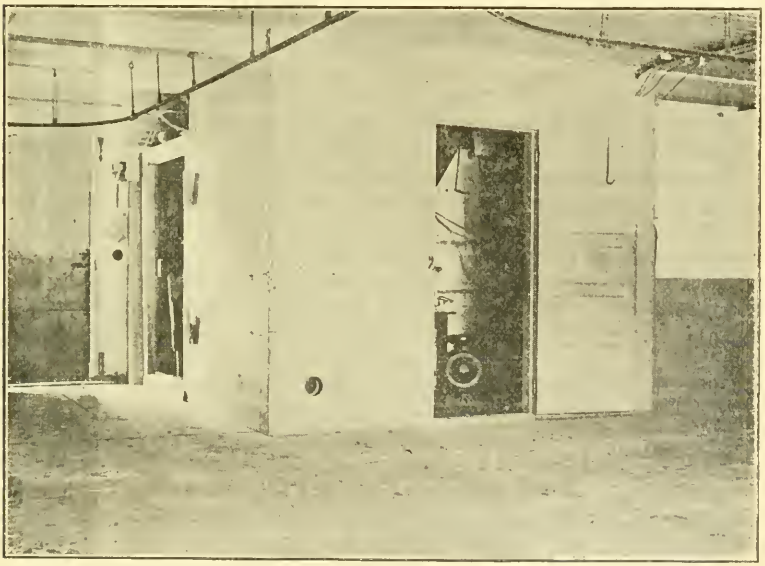
Fund, and then those under the Miscellaneous Fund. Broadly speaking, these are divided into the classifications mentioned at the beginning of this report.

RESULTS OF WORK IN ADAMS PROJECTS.

Studies in Animal Nutrition.

The principle of the balanced ration, as worked out in the various experiment stations of the country, has resulted in untold savings to farmers in the practice of stock feeding. Most of the background of this subject, however, is still only roughly charted. The physiological reactions of animals to different treatments in feeding and at varying stages of development have not been fully determined. Perhaps the main reason for this lack of investigation has been the cost of proper equipment for the determination of feeding values; and the construction at this Station of an inexpensive respiration chamber for domestic animals may, as the Experiment Station Record puts it, "serve to stimulate investigation and have a profound influence on the progress of nutrition inquiry."*

This chamber, the first of its kind, and a supplement to the primary chamber at the Pennsylvania Station, was constructed here three years ago by



The respiration chamber used in the nutrition studies.

Dr. F. G. Benedict of the Nutrition Laboratory, Carnegie Institution, who is co-operating with us and sharing the expenses of the project. It has been described at length in Technical Bulletin No. 16, and in the reference

*Experiment Station Record, U. S. Department of Agriculture. January, 1921. Vol. 44, No. 1. p. 8.

noted above. The work has been under the local direction of E. G. Ritzman (Animal Husbandry). Chemical analyses were made by H. R. Kraybill (Agricultural Chemistry).

The first two years' work consisted in the study of basal metabolism in steers. During the past year an exhaustive study has been made of the basal metabolism in sheep, from the first stage of pregnancy to maturity. The animals were studied in groups numbering from 8 to 16 head, and represented the equivalent of about 1500 individuals run through the chamber. A variety of interesting and valuable results have so far been obtained. Messrs. Benedict and Ritzman have found it more and more evident in the course of their investigations that the whole framework of our knowledge in this line still rests on a rather indefinite basis. The influence of varying amounts of crude fiber and concentrates and their retention in the digestive tract have materially complicated the problem of obtaining the true energy metabolism under post-absorptive conditions. In fact, a large amount of data representing digestibility of feeds is based on assumed values on this account and their reliability must remain in question until established by true basal investigations.

In the coming year's work an attempt is to be made to derive more knowledge along these lines, together with such correlated factors in energy exchange as surface area and skin radiation, the effect of varying amounts of crude fiber on fill and consequently on total live weight in relation to live empty weight, etc.

Two grade Shorthorn steers of good type have been purchased for this purpose and the equipment has been moved into new quarters especially prepared for this purpose. A chemist has been added to the staff to facilitate determinations on feed and excreta.

The results of the first two years' work are now being prepared for publication as a monograph of the Nutrition Laboratory of the Carnegie Institution of Washington, and as soon as this is in print the more practical phases will be discussed in the bulletin series of this Station.

How Much Feed is Necessary? The question of how large a meal is essential to the health of an animal has an especially important bearing on local problems in New Hampshire, since most of the concentrated stock feed used is grown in the West. The high price of this feed has brought about a noticeable decrease in its use and a greater dependence on home-grown hay, often with a lowered standard of wintering live stock. Mr. Ritzman has studied the effect on health and weight resulting from this practice, especially where it involved the feeding of maintenance and sub-maintenance rations composed solely of native hay. He has also carried the investigation into the consequent refeeding with grain and pasturing of animals that have been thus roughed through the winter. The studies of growth and gain show that, even with hay at present prices, it is decidedly uneconomical to feed less than a maintenance ration—a practice which is not uncommon in the New England states.

Feeding Value of Native Hay Determined. The feeding tables by which the value of rations is computed do not take into account the variations due to differences in soil, climate, nor the material changes in the composition

of feeds that have been brought about by seed selection, such as, for example, an increased protein content in some strains of corn. This problem has a decidedly local application in the question of New Hampshire hay. How does typical native hay compare, in chemical analysis and digestibility, with the hay used in the standard feeding tables? Any variation here is important, since for nearly six months out of twelve native hay is the basis of rations in practically every barn in the state.

As a part of the nutrition studies it has been possible to make an investigation into the feeding qualities of typical native hay, and the results show a somewhat higher energy value than that generally represented in the old feeding standards and a deficiency of protein.

Sheep Breeding Experiment.

Investigations in animal breeding proceed slowly since it is usually necessary to produce several generations of offspring in order to draw definite conclusions. The work in sheep breeding has now run over a period of about fourteen years, the last ten of which have been devoted to a study of the nature in which the various characteristics and functions are transmitted. Crosses of Southdown with Rambouillet and Hampshire with Rambouillet have been made and the offspring carried to three generations with careful observations of traits and measurements of conformations. The experiment is now at the stage where it is possible to make conclusions with regard to the application of Mendel's Law in practical sheep breeding; for the coming year's lamb crop should supply the last information necessary on the inheritance of conformation.

Mr. Ritzman, who has the work in charge, does not hesitate to state, as a result of the data already in hand, that definite progress toward strains of sheep possessing desirable combinations of wool and mutton can be established in three generations of breeding. The extent to which the work has already been successful in this respect may be judged by the fact that, on the one hand, top wool prices have been obtained on an open market during the past three years, while, on the other hand, there has been an exceptionally quick growth and early maturity of lambs. This latter point has been the main objective from the meat point of view, with good mutton conformation of adults a secondary requisite. The reason for this is that the lamb is a more profitable market product than mutton. The following lamb weights indicate the measure of success attained:

	Weight of Lambs, Pounds (a)		
	12 weeks	16 weeks	20 weeks
Average Single Lambs	49.6	55.4	63.6
Heaviest Single Lambs	68.0	69.0	86.0
Pairs of Twin Lambs	90.0	95.1	110.3
Heaviest Pair of Twins	100.0	106.0	124.0

(a) Weights after 12 weeks represent growth on pasture with practical elimination of grain and milk in diet. Hence small gains between 12th and 16th weeks are due to feed readjustment.

As for the wool, practical expert graders have repeatedly stated that "no better is grown anywhere in the country."

It has, however, been necessary, while making the principal study one of methods, to use parent breeds that represent extreme contrasts in conformation and wool. Now that the more theoretical phase of the experiment is completed, and it is possible to go ahead with the work of actually establishing a new strain, it does not seem necessary or advisable to use such extremes. Several individual crosses with Oxford-Rambouillet give even a higher promise than the Southdown-Rambouillet or Hampshire-Rambouillet, since they more directly appeal to farmers because of their size. It is proposed to extend the work further in this direction, as a proof that the principles determined can be used in building up a new and improved strain of sheep. Moreover, it will no longer be necessary to retain all offspring, whether good or inferior, as has been essential during the studies in genetics. Only the more promising family groups will now be retained as a nucleus.

A bulletin of the scientific series summarizing the observations and data on inheritance of wool characters is under preparation.

In the sheep breeding work, as well as in the nutrition studies, the Station has been fortunate in having the co-operation of one of the foremost international authorities in this field. Dr. C. B. Davenport of the Carnegie Institution of Washington has helped in an advisory capacity, and his untiring efforts and deep grasp of fundamental problems have in a great measure assured the successful progress of the work.

Effect of Bordeaux Mixture on Plants.

Wholly apart from its value as a fungicide Bordeaux mixture has been found to have a stimulatory effect upon the growth of plants. The investigations by O. Butler (Botany) have been continued with a view to determining what factors are responsible for this; and results will be published shortly. During the past year the study has dealt with the temperature changes in sprayed leaves, with special attention to the rate of change following insolation.

Toxic Action of Fungicides.

Sulphur and a number of copper washes have been studied by W. L. Doran (Botany) during the year with a view to determining their toxic action upon apple scab, early blight of potatoes, brown-rot fungus and white pine blister rust (*Venturia inaequalis, Alternaria solani Sclerotinia fructigena and Cronartium ribicola*). The conditions necessary for sulphur to act as a fungicide have been determined, and as a result of this study it has been possible to forecast the degree of control to be secured under given climatic conditions. In the case of the copper fungicides the relative toxicity of a variety of Bordeaux mixtures and other copper washes has been tested.

Plant Metabolism Studies.

The question of how plants feed is no less important than that of animal nutrition. Particularly has the relation of this question to fruit production received a great deal of attention during the past few years, as the interest

in the problems of apple culture testifies. Recognizing this fact, H. R. Kraybill and T. O. Smith (Agricultural Chemistry) began investigations last year in the subject of plant metabolism, a field in which Mr. Kraybill has been associated in previous work.

The literature of this subject has placed particular emphasis upon the relation of different amounts of available nitrogen and carbohydrates to growth and fruit production. In general there seems to be associated with fruit production a more or less definite relation of available carbohydrates to nitrogen. The quantity of nitrogen available to the plant has been modified by varying the supply of nitrogen in the soil or the nutrient solution; and it is probable that modifying the available supply of other elements to plants will also affect the relation of available carbohydrates and nitrogen. It is also evident that before we can clearly understand the relation of nutrition to fruit production all of the factors which affect the nutrition of the plant must be taken into consideration.

In carrying out this project the tomato plant is being used, because it is suitable for experiments under more or less controlled conditions and because of its similarity to the fruit tree in responses of growth and reproduction. During the past year two sets of plants have been grown in sand in the greenhouse. The first set consisted of four lots, receiving the following nutrient solutions respectively:—Lot 1—complete nutrient solution; Lot 2—nutrient solution without nitrogen; Lot 3—nutrient solution without sulphur; Lot 4—nutrient solution without phosphorus. The second set was a duplication of the first set but carried on at a different season of the year.

Samples of the leaves and stems of the plant from the different lots have been preserved and are being analyzed. Photographs were taken of typical plants from the different lots, and the number of blossom clusters, blossoms, fruit set, and fruit dropped was recorded. Catalase studies of samples of the plants under the different conditions, and micro-chemical examinations for starch and nitrate nitrogen were made.

Control of Root Maggots.

For a number of years investigations in the control of the cabbage maggot by insecticides have been carried on here by W. C. O'Kane (Entomology); and the data secured has shown a marked efficiency for a tobacco-dust-lime mixture, composed of equal parts of finely ground tobacco-dust and limestone, commonly known as agricultural lime.

The investigations of the present season were arranged to throw light on the underlying causes responsible for the definite effects observed in previous years. Determinations were sought as to the following: whether the mixture affected the vitality of the egg stage and, if so, to what degree; what effects may exist on the larval and the pupal stages; what results might be brought about by the addition of moisture, as in rain-fall; whether the dry mixture exerts a repellent action on the adults. Along with these experiments others were planned to determine the possible reaction of the adults to a poison bait of bananas and sodium arsenite. indicated in last year's studies.

Careful studies of eggs in contact with the tobacco-dust-lime mixture showed a definite insecticidal action. In one series eggs placed in contact with soil in the normal manner gave a 100% hatch, whereas eggs placed in contact with the mixture gave a percentage of hatch ranging from zero to 31%. In a second series, the percentage of hatch in the treated lots was 14% while in the check lots it was 82%. In a third series the hatch in the treated lots was 5% and in the check lots 71%.

Counts of larvae and pupae on the roots of plants which had received the mixture indicated a failure of larvae to reach the roots on treated plants for a period of several days following the treatment, but later an increasing number of larvae appeared on the roots. This phase of the study has a definite bearing on eventual use of the treatment, because the more serious damage is done by the maggots that reach the roots early, before the plant is well established and before it has built up an extensive root system. Thus, 60 plants which had been treated with tobacco-dust-lime showed at the end of four weeks 29 pupae, whereas 60 check plants showed 158 pupae. A parallel experiment with 75 plants treated with the mixture gave 82 pupae, where 75 check plants gave 162 pupae.

The addition of moisture to simulate rain, after newly-deposited eggs had been placed in contact with the mixture, resulted in a hatch of 16% as compared with a hatch of 93% where the eggs were placed in contact with soil, and water added. On the other hand, where eggs were placed on soil and wet down with an infusion made by permitting the mixture to stand in water, the percentage of eggs that hatched was nearly as great as that of check plots.

Experiments carried out to determine whether maggots on the roots of plants are killed by infusions of the mixture carried down through the soil, gave inconclusive results. There was a mortality varying from 4% to 10% as compared with a mortality of 0% in the case of the checks. Also, in the case of pupae, carried through a similar series of experiments, the results were inconclusive. The number of flies emerging in the case of treated pupae varied from 0% to 6% as compared with 10% in the case of the checks.

Experiments to determine whether flies lay eggs as freely in the case of treated plants as in the case of checks gave interesting results. The plants in these experiments were set out at a time when ovipositing flies were abundant, and treatment was applied immediately. Examination of these and of checks was begun two days later and was continued every 48 to 72 hours for four weeks. Egg-laying began promptly on the checks. The number of eggs recorded on the checks increased in the various observations and reached 199 eggs on 25 plants at the 14th day. In the case of the two lots of 25 plants each, treated with the mixture, 2 eggs were observed in the case of one lot on the 8th day and 1 egg in the case of the other lot on the 11th day.

A very heavy rain on the 16th day was followed promptly by visits of large numbers of flies to the treated plants showing that heavy rains rapidly reduce efficiency. A further treatment four days after the rain again appeared to give protection.

Observations to determine the possible utility of a poison bait, consisting

of banana pulp and sodium arsenite, gave inconclusive results. In cage experiments the previous year it was noted that the adult flies were attracted to banana, either sliced or made into pulp. Following this clue a more extended study was carried out. As in the previous year flies were attracted to the banana pulp, including both the check, where unpoisoned banana pulp was used, and the treated, where sodium arsenite was added to the pulp. Some flies were poisoned and their dead bodies recovered. But apparently the treatment was not effective enough to reduce egg-laying in marked degree, especially as the season progressed. During the first three days after treatment the number of eggs recovered from 125 plants in the check plots was 25, as compared with 3 eggs recovered from 125 plants in the treated plot. As the season advanced, however, no difference could be discerned from counts of eggs.

Fruit Bud Formation.

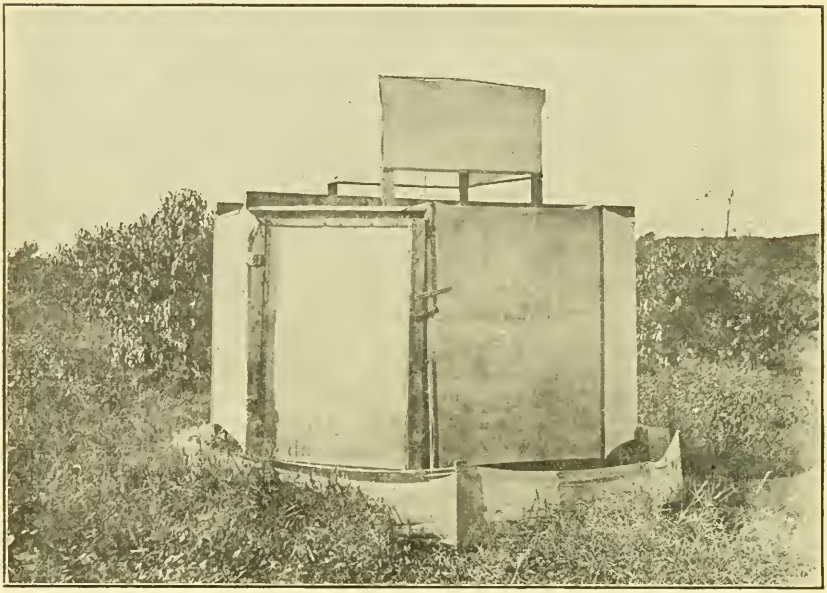
The study of the underlying causes of fruit bud formation, which has been in progress with Baldwin apples at the Woodman Orchard since 1908, was maintained last year along the usual lines by G. F. Potter and S. W. Wentworth (Horticulture). The plots receiving fertilizer in addition to cultivation and cover crops continued to show greatest growth as measured by diameter of trunk and annual twig growth. From the fertilized plots the crop for the 1920 season was on the average about 50% larger than from the unfertilized plots receiving the same cultural treatments. It is believed that the fertilized trees are also bearing more regularly, but it will take data from several seasons to establish this fact.

The probable error for the average yield and growth per tree in each plot has been computed, and, as might be expected, has been found to be high in relation to the yield in the three plots having a small number of trees. These plots are Number 1 in sod and Numbers 2 and 3, tilled in alternate years. This corroborates the opinion expressed in previous publications that the anomalous difference in yield between Plots 2 and 3, which receive the same treatment, is merely due to chance.

In addition to the usual work in this project the chemical phases involved in the study have been actively prosecuted in co-operation with Mr. Kraybill (Agricultural Chemistry).

Effects of Light upon Fruit Production. The results of the shading work conducted by J. H. Gourley (Horticulture) have now been published in the Station technical series. Chemical analyses have been made by Mr. Kraybill of samples taken from the growth of shaded and unshaded trees during the past two years, and show the former to be higher in moisture and total nitrogen, and lower in free reducing sugars and starch. It is evident that the factor of greatest importance which is influenced by shading is the amount of carbohydrates synthesized by the leaves and stored in the fruit spurs. We know practically nothing about this process in normal trees. An extensive investigation has therefore been made during the past year of bearing and non-bearing fruit spurs from trees in sod and trees under conditions of good culture and high fertility. Duplicate samples were taken at

intervals of one week during the active growing season and then at intervals of two weeks and finally at intervals of one month. Analyses are being made of these samples to determine moisture, total nitrogen, free reducing sugars, sucrose, maltose, starch and acid hydrolyzable material, ash,



Type of screen used in experiment in study of shading horticultural plants

total sulphur and total phosphorus. Leaf areas from the spurs were measured to determine the correlated synthesizing area at each period. The seasonal growth of and per cent. of bloom formed by each type of spur investigated will be determined in the spring of 1922; and with this information it is believed that the light investigation can be more advantageously prosecuted.

Effects of Girdling upon Fruit Production. The girdling experiment conducted in 1919 was repeated in 1920 using another set of trees. At the time of girdling on June 1, samples showed practically no difference in composition; but on July 8 and Sept. 4 the samples from the girdled trees were lower in total nitrogen and moisture and higher in free reducing sugars and sucrose. This corresponds to the results of the previous year. The girdling of the trees in both years increased fruit bud formation.

Winter Injury of Apple Roots.

The subject of winter injury to apple trees is a serious one to fruit growers; and an investigation along this line has been started at this Station during the past year by Mr. Potter in continuation of previous studies made by him at the University of Wisconsin. The object of the study will be four-

fold: (1) to determine what tissues are injured by cold, and the differences in structure and composition between hardy and tender tissues; (2) to determine what environmental conditions during the freezing and thawing process influence the degree of injury; (3) to determine what conditions of growth and nutrition tend to produce hardy tissues; (4) to test the feasibility of developing a hereditarily hardy strain of root stocks which may be propagated vegetatively.

Approximately two thousand seedling apple roots were frozen last year in tests designed to study the effect of freezing under different conditions. The data obtained does not wholly agree with that previously obtained in similar experiments. The roots were subjected under varying conditions to a critical cold temperature of about —7.8° C. Immediately after freezing they were planted in soil in the greenhouse and allowed to grow for from sixty to ninety days. Observations were then made on the proportion killed or injured.

In the case of nine duplicate lots of roots the temperature was regulated to fall slowly from freezing to the minimum and they were removed one half hour after the minimum was reached. In comparison another series was held four hours and one series eighteen hours at the miminum. The two last series were found to be injured slightly more than the first, but the difference was not great considering the accuracy with which it is possible to determine the amount of injury. Previous experience had indicated that there was practically no difference between lots exposed to the same minimum temperature for long or short periods.

One series of seven lots was frozen as rapidly as possible instead of at the usual slow rate. A markedly greater injury resulted, although in previous experiments little difference had been noted.

A series of tests each respectively in dry, medium wet and very wet sand showed greatest injury in the wet sand.

A series in which the roots were air dried for 24 hours previous to freezing showed less injury from cold than normal turgid roots, but the drying in itself killed many roots, as was evidenced by the dying of many of the dry check roots which were not frozen.

To gather further data on the relative hardiness of cion roots from different varieties of trees, ten trees each of Hibernal, Duchess, Dudley and Northwestern, which had thrown out roots above the union with the stock were secured. These cion roots together with stock roots from the same trees were subjected to a critical freezing temperature. Duchess and Hibernal proved most hardy, Dudley next and Northwestern least hardy, results which accord with previous experience.

In freezing seedling roots some individuals prove much more hardy in the same test than others.

To determine whether this difference is related to the differences in size of the roots, 300 roots which had been measured were frozen and a correlation table constructed. It was shown emphatically that the injury is not proportional to the diameter of the seedling, the coefficient of correlation being —0.04 plus or minus 0.04.

Two hundred roots were divided lengthwise into three sections. The top and the bottom sections were frozen at different times. The data obtained shows that there is a strong correlation between the amount of injury to the top section, and to the bottom section. The relative hardiness of individual roots must, therefore, be due to some internal difference. A sample from the middle sections of roots which were not killed and another from roots which were entirely killed were preserved for chemical analysis. Other sections were preserved for the preparation of microscope slides. The analysis and sectioning are not yet done.

A considerable amount of material for the continuance of this work is being grown in the nursery, and the investigation is to be continued this season.

RESULTS OF WORK IN HATCH PROJECTS.

Improvement of Timothy.

The work in timothy selection, which is being conducted with a view to securing a superior strain particularly suited to New Hampshire, reached a point last year where it was possible to send out selected seed for trial in other portions of the state. A careful process of selection has been craried on by F. W. Taylor (Agronomy) since 1912 along this line. From the 3000 plants set out in 1920, one hundred of the most promising were selected last year. A further selection and culling of these 100 to about 20 will be made next season, and from these seed will be saved for setting out another individual test plot of 3000 plants in the fall.

Of the selected seed last year six 2-lb. lots were sent to county agents to be tried out by farmers. Three ounces of the seed were also sent to the agricultural instructor in each of the fifteen rural high schools of the state to be grown in school garden rows in comparison with other strains.

Variety Tests of Ensilage Corn.

Tests with ensilage corn were again carried on last year by Mr. Taylor and M. G. Eastman (Agronomy). Three rows 40 rods long of each of 16 varieties were planted May 21. The ground was well manured and the usual methods of cultivation were practiced. The hot dry weather of late summer enabled the corn to mature well. It was cut into the silo September 17, and samples of each variety were bagged for subsequent analyses of the resulting silage.

The names and yields per acre of the several varieties were as follows:

Variety	Tons per A.	Variety	Tons per A
Eureka	22.92	Brewer's Dent	10.06
*Cornell No. 11	12.75	Early Lakeside	15.03
Imp. Leaming	14.31	*Webber Dent	12.13
Leaming	16.28	*Minnesota 13	13.69
Cuban Giant	15.55	*Early Yellow Dent	12.86
Clarage	11.51	*Luce's Favorite	9.54
Red Cob	12.96	*Pride of the North	10.78
*N. H. 500	8.19	*Sanford	9.33

*These varieties were fully matured at cutting time. The Eureka and Cuban Giant were the latest and had very few ears.

Soil Rejuvenation Study.

Numerous inquiries relative to the use of green manure crops have added emphasis to the fact that many acres of possible tillage land in New Hampshire are becoming depleted in nitrogen and organic matter.

Recognizing the possibility of correcting some of these deficiencies by means of green manures together with certain mineral fertilizers, a series of plots covering two acres of an old hay field were laid out in the fall of 1920 by Messrs. Eastman and Kraybill. These plots are on a sandy loam soil, are one-quarter acre each and are run in duplicate. Previous to the planting of the plots, the soil was analyzed for acidity and was found to have an average lime requirement of nearly 3 1-2 tons of ground limestone per acre. The entire plot was limed on this basis.

The plots are treated as follows:

No. 1.—Fall plowed and seeded to rye and vetch; this crop plowed under in the spring and seeded to oats with clover and timothy.

No. 2.—Fall plowed and seeded to rye and vetch; this crop plowed under in the spring and seeded to oats and peas to be plowed under in late summer and again seeded to rye and vetch to be plowed under the following spring, at which time the plot is to be seeded to oats with timothy and clover.

No. 3.—Same as No. 2 except that buckwheat and soy beans are substituted for oats and peas in the series.

No. 4.—Fall plowed and seeded to oats with clover and timothy the following spring.

In order to study the effect of certain mineral fertilizers each of the foregoing plots was divided into five sections which were treated as follows:—

(a) With raw rock phosphate and gypsum.
(b) With acid phosphate.
(c) With nitrate of soda, raw rock and gypsum.
(d) With nitrate of soda and acid phosphate.
(e) No treatment.

A similar series of tests was begun on a second two-acre tract in the fall of 1921. This second tract is a heavy boulder clay soil, low lying, and has not been plowed or fertilized for more than forty years.

On the first tract poor yields of rye and vetch were secured the first season. The buckwheat made a fair growth but the yields of soy beans and oat fodder were very light.

Sunflowers for Silage.

This was the third season that Mr. Taylor has tried sunflowers out as a silage crop. The yield per acre on the plot this year was 22.58 tons per acre. This is about 70 per cent. greater than the average yield of the several varieties of corn. The sunflowers were planted thicker than usual and made a good yield of average size stalks. Our results indicate that where corn cannot be successfully grown, the sunflowers furnish a good substitute as a silage crop. The quality of the silage as indicated in our first year tests was almost as good as that of corn silage. Even where corn can be grown successfully it would seem that sunflowers mixed in with it will increase the yield, particularly on "witchy" ground.

Soy Bean Inoculation.

The tests of the previous year in which four different commercial cultures were used to inoculate the beans were repeated by Mr. Eastman. All of the inoculated plants showed a remarkable difference in color and also in the number of root nodules in comparison with the uninoculated. Chemical analyses showed 2.26 per cent. nitrogen in the leaves and stems of the inoculated plants as against 1.79 in the uninoculated. In other words the inoculated plants contained about 26% more nitrogen than the uninoculated. From this and other tests it is quite evident that inoculation should be resorted to where soy beans are grown for the first time on a given piece of ground.

Early Planting of Ensilage Corn.

This work was conducted this season for the second time by Mr. Taylor, in co-operation with the Federal Bureau of Plant Industry. The premise was that larger yields and a better quality of silage corn could be secured in the more northern latitudes by planting the later varieties several weeks earlier than the usual planting season. Three varieties, Mt. Hope Dent, U. S. No. 119, and U. S. No. 193 were furnished by the Bureau. Two rows of each variety were planted on a high, well drained piece of stony loam soil on four different dates:—May 4, May 14, May 24, and June 3.

The first planting required 15 days to come up, and the second 10 days. After the first month no difference in these two plantings could be noted throughout the season. At harvest time, September 16, little or no difference in the growth and maturity of the first three plantings could be noted. The fourth or last planting showed a marked difference particularly in the maturity of the ears and the color of the leaves. While the lower leaves on the earlier plantings were dry and brown, those on the last planting were all green and vigorous. This was probably a seasonal effect due to the very dry weather of August and early September.

While no data was secured on the comparative yields per acre, the early plantings did not seem to be noticeably better for silage than the later. Further observations on the question at issue, however, must be made before definite conclusions can be reached.

Lime Requirement of the Soils of New Hampshire.

In connection with the studies in soil rejuvenation the necessity arises of liming soils in order to grow legumes successfully. In order to obtain more information regarding the lime requirements of the soils of New Hampshire, Mr. Kraybill made arrangements with the county agents to take samples of soils from various farms over the state and send them into the Chemical laboratory. Description sheets were filled out by the county agents giving the location and characteristics of the soils sampled. The soils were tested at once by means of the Truog method and the results reported to the county agents so that they were available for the farmer. These samples of soils have been carefully preserved and are being used for a more careful study of the soils of the state.

The following table gives a summary of the results of this season's work:

County	No. of Samples	Acreage Represented	Average Lime Requirement by the Truog Method
			Tons Ground Limestone
Merrimack....	93	255	$2\frac{3}{4}$
Belknap.....	52	345	3
Strafford.....	39	188	$2\frac{2}{3}$
Rockingham...	35	60	$3\frac{1}{4}$
Sullivan.....	10	10	3
Hillsborough...	23	121	3

Work in Potato Diseases.

During 1920-21 the farmers of the state, their interest awakened as a result of the severe losses due to late blight in 1920, showed increasing interest in potato diseases, especially the degeneration maladies—mosaic and leaf-roll. Messrs. Butler and Doran were therefore called upon to devote much time to field work and lectures upon these subjects. The growing of better seed potatoes was recommended and help was extended in securing choice seed stock.

The question of seed certification was also given attention, and the advantages of producing certified seed rather than ordinary stock were brought prominently to the attention of growers of seed potatoes.

Potato Spraying Experiments. In one experiment to determine the effect of pressure on the protection afforded by Bordeaux mixture, Mr. Butler found that, when the pressure used was reduced from 180 pounds per square inch, to 90 pounds per square inch, the protection afforded was reduced one-half. The mixture applied under 180 pounds pressure was more thoroughly distributed over the plants than that applied under 90 pounds pressure; and this probably accounts almost wholly for the better protection afforded, since the amount of copper applied per acre on doubling a given pressure is not increased by one-third.

In another experiment potatoes were sprayed on the one hand with a machine carrying two nozzles to the row and on the other with a machine carrying three nozzles to the row; the mixture used was applied under 90 pounds pressure in both cases. The results obtained were as follows:

Effect of Number of Nozzles Used per Row in Spraying on Late Blight Control.

No. of Nozzles Used Per Row	Protection Obtained, Relative Nos.
Not sprayed	1
2	1.1
3	10.0

In yet another experiment on the relative value of different Bordeaux mixtures and Burgundy mixture, the washes were applied fortnightly under 90 pounds pressure. The following results were obtained:

DEGREE OF CONTROL OF LATE BLIGHT OBTAINED WITH DIFFERENT BORDEAUX MIXTURES AND BURGUNDY MIXTURE

Mixtures Used	Blighted Tubers Harvested Relative Nos.
Bordeaux mixture 8-4-50	100
Bordeaux Mixture 6-3-50	106
Bordeaux mixture 4-4-50	163
Bordeaux mixture 4-4-50 Perret's formula	144
Burgundy mixture 4-7½-50	316

While late blight was not severe in any of the fields in which experimental spraying was carried on, it is nevertheless clear that Burgundy mixture, Perret's formula and 4-4-50 Bordeaux mixture do not compare favorably in protection with the 6-3-50 and 8-4-50 washes. The protection afforded by a 6-3-50 Bordeaux mixture should, under conditions favorable to the development of late blight, be less than that afforded by an 8-4-50 mixture if the ideas expressed in a previous publication are true.*

Under conditions of less severe infestation the two strengths would, as in fact they did, afford a protection more nearly alike.

Effect of Siccatives on Seed Potatoes. When potatoes are cut before planting, it is a common practice, especially when they are to be machine sown, to dust them with sulphur or gypsum or some other suitable substance to dry the cut surface and protect the seed piece from decaying. Sulphur is generally considered the best to use, though the reason for so considering it is not obvious.

When potatoes are machine planted, they go through the planter better when the cut surface has been dried; but has a drier any other value besides its siccative properties? Does sulphur, for instance, prevent decay of the seed piece better than either gypsum or tricalcic phosphate? In an attempt to answer this question Mr. Butler has for three successive years tested sulphur, gypsum and tricalcic phosphate. The results obtained are indicated in the following table:

*Butler, O. On the amount of copper required for the control of Phytophthora infestans, Phytopathology 10: 298-304. 1920.

Effect of Siccatives on Preventing Decay on the Potato Seed Piece.

Method of treatment	Condition of Seed Piece after 50 Days		
	Completely rotten	Partly rotten	Sound
	Per cent.	Per cent.	Per cent.
No treatment	1.5	23.6	74.9
Gypsum	21.3	10.4	68.3
Tricalcic phosphate	14.5	24.5	60.8
Sulphur	26.7	30.7	42.6

The data presented in the above table shows that gypsum is the best of the three substances experimented with, but not one of them is, in reality, better than no treatment at all in protecting the seed piece from decay.

Snapdragon Rust and Its Control.

In continuation of previous experiments a field of snapdragon plants thoroughly and uniformly affected with snapdragon rust was divided by Mr. Butler into sections and attempts made to control the malady by: 1. the use of dry sulphur; 2, basic acetate of copper; 3, Burgundy mixture; 4, basic copper acetate and dry sulphur; 5, Burgundy mixture and dry sulphur.

None of the methods used gave any material protection.

Effect of Phosphorus Upon the Time of Maturity of Tomatoes.

One of the most important factors in determining the commercial success of growing tomatoes for market is the time of maturity of the crop. Frequently the first portion of the crop may bring much more in money return than the mid-season portion, even though the total yield of the latter portion may be much the greater. This is due to the higher prices which prevail early in the season when the supply is limited. Under conditions such as prevail in New Hampshire frequently the latter part of the tomato crop is lost by frost injury because of the relatively short growing season.

This project was started by J. R. Hepler (Horticulture) and Mr. Kraybill in 1920 to determine whether the application of phosphorous fertilizers would hasten the maturity of the tomato. The fertilizer treatments of the plots were as follows:

Plot 1—Nothing..
Plot 2—20 tons manure per acre.
Plot 3—20 tons manure per acre.
1000 lbs. acid phosphate per acre.
Plot 4—20 tons manure per acre.
1000 lbs. gypsum per acre.
Plot 5—20 tons manure per acre.
500 lbs acid phosphate per acre.
Plot 6—20 tons manure per acre.
1000 lbs. acid phosphate per acre.
1000 lbs. muriate of potash per acre.

Plot 7—20 tons manure per acre.
1000 lbs. muriate of potash per acre.
Plot 8—20 tons manure per acre.
500 lbs. acid phosphate per acre.
500 lbs. muriate of potash per acre.

In 1920 there were two duplicate plots of each treatment, and in 1921 there were four. Records of the number of fruit and weight at each picking time were kept for each plant. The number of blossom clusters, the number of blossoms per cluster, the number of fruit set and the number of fruit dropped were recorded for 12 plants of each plot. This data is being tabulated and analyzed, and will be the subject of a later report.

Immature Forest Stands.

The sample plots of important economic forest trees were remeasured by K. W. Woodward (Forestry) who has a detailed statement of the results in preparation. It will be unnecessary to carry further the series of experiments designed to determine the effect upon white pine reproduction of overtopping by hardwoods. It has been shown conclusively that the hardwoods must be removed before the end of the first ten years or the pine will die.

Definite results have also been obtained as to the best methods and costs of lopping hardwoods.

The plots devoted to growth studies will be continued. These include the following species: white pine, Scotch pine, red pine, European larch, Norway spruce, Douglas fir, and white ash.

To replace the plots which have served their usefulness new ones intended to give data on the thinning of immature pine stands are being established.

Spraying for Apple Maggot.

In order to determine the efficiency of spraying with arsenate of lead as a means of control of the apple maggot under New Hampshire conditions, Mr. O'Kane has conducted further experiments in the crop seasons of 1920 and 1921. Experiments recorded in an earlier bulletin of this station gave negative results from spraying with a poisoned bait in which arsenate of lead was added to sweetened water, with the intent of attracting the flies to the drops of bait. The present experiments follow the plan of spraying a large area, leaving no checks, and using a simple mixture of arsenate of lead and water without the addition of sugar or other bait. The intent is to secure such wide distribution of the spray that flies feeding on the leaf surface will be poisoned. This is the basis of the spraying schedule recommended for the apple maggot in two or three other states.

Under New Hampshire conditions the experiments carried out last season gave negative results. The work of this season is inconclusive, because of a lack of abundance of the species in the areas under observation.

Control of Black Flies.

The experiments carried out in former years were continued by Mr. O'Kane through the present season. In addition, an increased number of collections were made at various points in New Hampshire, and the distribution of the various species was studied. Important observations were begun on the hibernating habits of these insects.

Termites.

The investigation of termites has now been practically completed by Mr. O'Kane. It has included observations on the use of repellent oils, experiments with traps to determine the location of parent colonies, and an extensive experiment with heat as a means of killing the insects within the timbers of a building. A bulletin is soon to be published covering the results of this investigation.

Insect Record.

A considerable amount of data has been added to the insect record maintained by the entomology department. There has been a notable increase in the numbers of the native Stalk borer (*Papaipema nitela*) and the native Corn Ear Worm (*Heliothis obsolcta*). The range of the European Corn Borer (*Pyrausta nubilalis*) in New Hampshire has been extended moderately and now includes 12 towns. There has been a marked increase in damage done by the Bean Weevil (*Bruchus obtectus*). Feeding by the Gipsy Moth (*Porthetria dispar*) has been extensive, but has been accompanied by an increase in the numbers of imported parasites. There has been a definite increase in the numbers of the Browntail Moth (*Euproctis chrysorrea*) in several localities.

Variety Tests of Fruits.

A late frost reduced the crop in the Thompson Orchard and Horticultural Farm and the harvest consisted largely of standard varieties such as Baldwin and McIntosh. Dudley and Golden Delicious were added to the list of apple plantings, and Waneta, Opata, and Sapa, of the hardy Hansen Hybrid type, to the list of plums. It is thought that residents of the colder portions of the state will be interested in the fruit from these trees.

Advice and aid has been given to H. B. Stevens in the planting of a filbert orchard, which is under observation by the Department of Horticulture, and will give information on the feasibility of growing this class of nuts in this latitude.

In co-operation with the United States Department of Agriculture, about 100 plants of high-bush cranberries have been planted. It is hoped that fruit from these selected bushes may be of value as a substitute for gooseberries and currants which are being eradicated to save the white pine of the state.

Strawberry variety tests, in which a few plants each of a large number of varieties assembled from various sources are grown, have been discontinued. A plantation of four leading varieties has been set on a sufficient scale to determine their commercial characteristics fairly accurately.

Apple Pruning Experiment.

This experiment has been continued by Mr. Potter as previously outlined to determine the best form of pruning. The difference between the vase-shaped trees and the others is now quite apparent. Since the leader is still being continued in the trees which are to be of modified leader form, these are still very similar to those which are to be of the leader type. The amount of wood removed in pruning and the diameters of the trees were measured

for the first time this season. There were no significant differences thus far between the different types in either diameter of trunk, or amount of prunings.

Peach Fertilization.

The work in the peach orchard has been continued by Mr. Potter as previously outlined. The trees had a full bloom, but owing to frost there was not enough fruit to warrant measuring the crop. The usual growth measurements indicate only that nitrogen is the chief element promoting growth.

Raspberry and Blackberry Experiment.

Fertilization and culture were continued as previously, but the plantation is not thriving. A small crop was harvested from the raspberries. Herbert red raspberry proved the best yielder. The crop was too small and the differences not pronounced enough to draw conclusions on the effect of different fertilizer treatments.

Grape Varieties and Fertilization.

This plantation is not thriving. Missing plants were replaced and the usual fertilizer applied, but no records were taken.

Maintenance of Soil Fertility in the Garden.

The soil fertility plots have been running since 1918 under the management of Mr. Hepler with a view to determining: (1) the minimum amount of manure necessary to obtain profitable vegetable crops on the soil in question; (2) to what extent green crops and fertilizers can be substituted for manure; (3) a profitable combination of chemical fertilizers and manure; and (4) the effect of lime upon crop production. The plots have been planted in previous years to kidney beans, sweet corn and potatoes. In 1921 they were planted to Danish Ball Head cabbage. The manure was applied early in the season, but the plots were not plowed until June excepting the green manure plots 3 and 7 which were plowed in April and sowed to oats for a green manure crop. The oats made a good growth and covered the plot to a depth of a foot when they were plowed under in June.

The cabbage was not set until the first week in July, since the soil was too dry up to that time. The width of the plots was reduced to thirty feet so as to lessen the danger of the overlapping of fertilizer treatments. This reduced the size of the plots from 1-8 of an acre to approximately 1-10 of an acre. About the same number of plants was set on each plot and very few failed to grow or were injured by diseases or insects. Only marketable mature heads were harvested and the weight figures given below are for cabbage trimmed for market.

The treatments of the different plots are as follows:

Plot 1—32 tons of manure per acre.

Plot 2—24 tons of manure per acre and the following commercial fertilizer per acre: 150 pounds tankage; 100 pounds nitrate of soda; 600 pounds acid phosphate; 150 pounds muriate of potash.

Plot 3—Green manure plus the following commercial fertilizers per acre: 160 pounds nitrate of soda; 250 pounds tankage; 800 pounds acid phosphate; 300 pounds muriate of potash.

Plot 4—16 tons of manure and the same fertilizer treatment as Plot 3.

Plot 5—Check plot.

Plot 6—8 tons of manure and the same fertilizer treatment as Plot 3.

Plot 7—Green manure plot.

The yields were as follows:

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Tot.	Per acre	Tons per acre
No. of heads.....	579	560	585	601	501	560	426	3812	5084	
Wt. of heads.	4775 lbs.	4550	4265	4830	1680	3525	1000	24625	32836	16.4
Wt. per head.	8.3 lbs.	8.1	7.3	8.0	3.3	6.5	2.3	6.4		
Tons per acre.....	23.9	22.8	21.3	24.2	8.4	17.6	5.0	17.6		
Compared with ck. 5 .	3095 lbs.	2870	2585	3150	check	1845	-680			
Ave. in %.....	184.2	171.1	153.8	187.5		109 8	-40.5			

Value of Crop Less Cost of Fertilizer. The value of fertilizer treatment is shown in the following table showing the crop values in the different plots. The manure was valued at $2.50 per load and the other fertilizer at the 1921 spring prices as follows:

Nitrate of Soda	$70 per ton
Tankage	39 per ton
Acid Phosphate	29 per ton
Potash	100 per ton

The cabbage is valued at $25.00 per ton which was the market price at the time it was sold.

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7
Yield in lbs.	4775	4550	4265	4830	1680	3525	1000
Value per plot.....	$59.69	56.88	53.31	60.38	21.00	44.06	12.50
Value of fertilizer.....	8.00	8.26	4.20	7.70		5.70	.50
Value of crop less fertilizer.....	$51.69	48.62	49.11	52.68	21.00	38.36	12.00
Compared to check.....	$30.69	27 62	28.11	31.68		17.36	-9.00
% Comparison.....	146.1	131.5	133.9	150.9		82.7	-42.9
Acre value of crop less fertilizer.....	$516.90	486.20	491.10	526.80	210.00	383.60	120.00
Acre compared to check..	$306.90	276.20	281.10	316.80		173.60	-90.00

Value of Lime on Cabbage.

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Total
No. of heads.....	299	284	284	296	230	283	208	1884
Limed Weight	2425 lbs.	2075	2075	2445	955	1725	465	12165
No. of heads.....	280	276	301	305	271	277	218	1928
Unlimed Weight.....	2350 lbs.	2475	2190	2385	725	1800	535	12460
Ave. Wt. Limed.....	8.1 lbs.	7.3	7.3	8.3	4.1	6.1	2.2	6.45
Ave. Wt. Unlimed.	8.4 lbs.	8.9	7.3	7.8	2.7	6.5	2.5	6.46
Comp. Weight.....	75 lbs.	-400	-115	60	230	-75	-70	-295
Percentage comparison.....	3.1%	-16.3	-5.2	2.5	31.7	-4.1	-13.1	-2.4

The lime had very little effect on the cabbage as may be seen from the above table. Only two plots show a marked deviation,—Plot 2 with a decrease of 16.3% and Plot 5 with an increase of 31.7%.

Tomato Spraying Experiments.

One of the important diseases affecting the tomato under glass is the leaf mold (*Cladasporium folorum*). Various spray mixtures are recommended for its control, among which are Bordeaux mixture, Ammoniacal copper carbonate and Formalin in varying strengths.

In the spring of 1921 one greenhouse was planted by Mr. Hepler to tomatoes and the plants sprayed according to the following plan:

Row 1—Untreated and eliminated.
Row 2—Formalin 1-75.
Row 3—Ammoniacal copper carbonate.
Row 4—Check (unsprayed)
Row 5—Bordeaux 4-4-50.
Row 6—Bordeaux 4-2-50.
Row 7—Formalin 1-500.
Row 8—Formalin 1-750.
Row 9—Ammoniacal copper carbonate.
Row 10—Check.
Row 11—Bordeaux 4-4-50.
Row 12—Bordeaux 4-2-50.
Row 13—Formalin 1-500.
Row 14—Untreated and eliminated.

The results as follows are the totals for both sets of rows:

	No. of Tomatoes	Wt. in oz.	Av. Wt. per fruit	Comparison
Check Rows	410	1064 5–8	2.5 oz.	100%
Bordeaux 4–4–50	418	1013 5–8	2.4 oz.	95% of check
Bordeaux 4–2–50	375	847 1–2	2.3 oz.	79.5%
Formalin 1–500	380	980 6–8	2.6 oz.	92.1%
Formalin 1–750	333	784 3–8	2.3 oz.	73.7%

The spraying did not benefit the plants in the absence of disease, and in the case of the 4-2-50 Bordeaux and 1-750 formalin treatments reduced yields materially.

Suckering Sweet Corn.

In an experiment to determine the effect of suckering on sweet corn, 2 rows of Early Crosby, 250 feet long, were suckered and 2 left as a check. The corn was suckered at the time the suckers were half grown and before the ears appeared on the main stalk.

The yields were found by Mr. Hepler to be as follows:

	No. of ears	Weight	Ave. size in lbs.	Ave. size in oz.
Unsuckered	1106	595 lbs.	.54	8.6
Suckered	989	560 lbs.	.56	8.9

This shows an increase of 5.8% in favor of the unsuckered corn. The ears of the suckered corn averaged 1-3 of an ounce larger. The difference in yield is so small that it is not significant, showing that suckering was not profitable in 1921.

Four rows of Bantam corn 250 feet in length, showed the following results:

	No. of ears	Weight	Ave. size in lbs.	Ave. size in oz.
2 rows unsuckered.....	638	231.5	.36	5.7
2 rows suckered.....	662	237.5	.36	5.7

The Golden Bantam gives a slight increase, 2.6% in favor of the suckered corn with the size of the ears practically the same, but the difference is so small that the results are negative.

Tomato Selection Experiment.

Individual yield records were taken by Mr. Hepler of the yield of 1064 Bonny Best tomato plants in the 32 soil fertility plots. Fruit from the highest yielding plant and the lowest yielding plant in each plot was selected and the seed saved. The yield of each of these 64 strains will be determined in order to isolate an early high yielding strain of Bonny Best tomatoes for New Hampshire.

The value of selection on yield and earliness will also be studied.

Effects of Borax on Plant Life.

Because of the presence of borax in some of the domestic sources of potash and extensive crop injuries traced to this source, the eight experiment stations of the northeastern states arranged for co-operative work on the problem during the winter and spring of 1920. Greenhouse tests were conducted at the Vermont Station by J. R. Neller, with each station bearing its proportionate part of the expense involved. In the experiments borax-free fertilizer, to which borax was added in definite amounts was used on corn, potatoes and beans. The tests showed that a given borax application was most liable to be harmful if applied in drills below the seed or seed pieces. Bean and corn plants proved more susceptible to injury than potatoes. Under the conditions of the experiment anhydrous borax at the rate of three pounds per acre was the largest amount that could be applied in drills with safety to beans. The limit for corn proved somewhat under five pounds and for potatoes slightly above five pounds. Applications of lime were found to prevent some of the injury to all three crops, while gypsum and manure were also beneficial with corn.

This was the first attempt at conducting co-operative experiments on the part of the northeastern experiment stations, and may well be the beginning of other valuable co-operative effort.

RESULTS OF WORK IN MISCELLANEOUS PROJECTS.

Inspection of Commercial Feedstuffs.

Two hundred and fifty samples of commercial feeding stuffs were analyzed for the State Department of Agriculture by T. O. Smith and C. P. Spaeth (Agricultural Chemistry) in connection with the enforcement of the state law regarding the selling of feed stuffs. The results of this work are reported in Bulletin No. 195 of the New Hampshire Agricultural Experiment Station. A co-operative arrangement with the Federal Bureau of Chemistry whereby samples shipped into the state which were found adulterated and misbranded are reported to the federal authorities, has secured action in a number of cases. This materially strengthens the protection given to the purchasers of feed stuffs in the state.

Inspection of Commercial Fertilizers.

One hundred and four samples of commercial fertilizers were analyzed for the State Department of Agriculture by Messrs. Smith and Spaeth. The results of this work are reported in Bulletin No. 196 of this Station.

Seed Tests.

Mr. Eastman tested 610 samples of grass and grain seed for farmers, county agents, dealers and the State Department of Agriculture during the past year. The results of these tests will be found in Station Bulletin No. 197.

Advanced Registry Work.

Following is a summary of Advanced Registry work as supervised by J. M. Fuller (Dairy Husbandry) July 1, 1920 to June 30, 1921:

Official Tests

	Cows Tested
Holstein seven-day tests	26

Semi-official or yearly tests

	Cows entered on test
Milking Shorthorns	2
Ayrshires	9
Holsteins	33
Jerseys	29
Guernseys	65
Total	138

For the year ending June 30, 1920, the number of seven-day tests was 49; of semi-official or yearly, 178.

White Diarrhea Work.

Tests were made of 17,000 hens during the past year by A. W. Richardson and P. I. Fitts (Poultry Husbandry) and resulted in the finding of ten poultry farms, of 300 hens or over each, which were free from the disease of white diarrhea. These farms hatched at least 100,000 chicks which were scattered broadcast over the state, in many cases establishing new flocks which after a year or so will be used to spread further the white diarrhea-free stock. From the results of last year's work nine new such flocks have already been established, making a total of nineteen now known to be free of the disease.

What this may mean to the poultry interests of the state is shown by the following instance of a Rockingham County poultryman. "Two years ago,"

he writes, "I hatched out 1900 chickens from untested stock, and raised about 250. This season from tested stock I hatched 1201, and I have a few over 1100 nice six weeks' old chickens." Another poultry farm reports a drop from 55% to 17% in the mortality of its chicks.

The project has been self-supporting since the income from the testing pays all the expenses.

Service Work.

Numerous requests for the analysis of various materials and for technical advice have come to the chemical laboratory during the past year. Over one hundred and fifty samples of materials have been analyzed including commercial feedstuffs, fertilizer, insecticides and fungicides, lime, wood ashes, soils for lime requirement, etc. When the nature of the work is such that it is of general interest to the community or state at large, the Station has felt justified in doing the work.

Publications.

The constant growth of the Station mailing list together with the high cost of printing has made a change in the distribution of our publications seem advisable. Formerly all of the regular bulletins were sent to every one who requested that his name be placed on the mailing list; but the increase in this list to 22,000 names placed a heavy burden upon the Station funds, and made it impossible to publish all of the manuscripts which it was desirable to bring out. Since the issuing of bulletins is the principal means of carrying to public attention the results accomplished, it is very important that publications should not be shelved for lack of funds. An economy which seems to work satisfactorily was started at the close of the last fiscal year by the adoption of the following policy: Postal cards announcing new bulletins are now sent to every one whose name is on the mailing list, with the request that desired bulletins be checked and the card returned to the Station office. By this means the mailing of bulletins is restricted to instances where they are actually wanted, and the financial saving under this system has proved sufficient to make the printing of more bulletins possible.

During the past year the following publications were issued:

Bulletins

195—Inspection of Commercial Feeding Stuffs.
196—Inspection of Commercial Fertilizers.
197—Results of Seed Tests—1920.
198—Report of Experiment Station Work, Biennium, 1918-20.
199—Digging up Facts for New Hampshire Farms.

Scientific Contributions

17—Earless Sheep.
18—Relation of Potassium to Growth of Plants.

Technical Bulletins

17—Experiments with Contact Sprays for Leaf Miners.
18—Effects of Shading Some Horticultural Plants.

Another method of getting the results of Station work into public knowledge has been pursued in the newspaper notices. Brief summaries in news

form are sent to the newspapers and farm journals. A total of 34 of these articles in addition to the regular extension series was issued during the past fiscal year. There has been a generous attitude on the part of most of the papers in the state to these reports; and the importance of service to the agricultural interests of the state is quite generally recognized by the press.

New Legislation, Personnel and Equipment.

The New Hampshire Legislature of 1921 included in its appropriation to the State College a special appropriation as follows: "for agricultural research work $5,000.00 for the fiscal year ending June 30, 1922, and $7,000.00 for the fiscal year ending June 30, 1923." This is the first appropriation to the Station for research work in the history of the institution.

There have been no changes in personnel since our last report except in the entomology department, from which C. R. Cleveland, assistant entomologist, resigned at the close of the fiscal year to take up research work at Purdue University. P. R. Lowry of the Ohio State University, has been appointed assistant entomologist in his place.

Apparatus added to the Station inventory during the past year includes a Leeds and Northrup equipment for determining the hydrogenion concentration by the gas chain method; an electric vacuum oven; a Millionaire calculating machine; a standard telescope and scale; and a Potter freezing apparatus, with which materials may be frozen at any automatically controlled rate. Electric heaters have been installed for making the digestions and distillations in connection with the nitrogen determinations, and an electric water bath with temperature control to 0.1°C. has been constructed.

The financial statement for the year is given in the following pages.

FINANCIAL REPORT TO THE UNITED STATES GOVERNMENT OF THE HATCH AND ADAMS FUNDS

For the Fiscal Year Ending June 30, 1921.

Dr.	Hatch Fund	Adams Fund
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ending June 30, 1921.	$15,000.00	$15,000.00
Cr.		
By Salaries	$9,451.85	$11,126.70
Labor	983.85	1,239.33
Publications	1,263.16	.....
Postage and stationery	533.30	7.54
Freight and express	349.75	17.95
Heat, light, water, and power	600.00	.....
Chemicals and laboratory supplies	65.16	420.96
Seeds, plants, and sundry supplies	250.22	269.39
Fertilizers	44.45	.....
Feeding Stuffs	.....	553.86
Library	361.45	.....
Tools, machinery, and appliances	17.29	78.89
Furniture and fixtures	325.00	28.50
Scientific apparatus and specimens	59.39	825.17
Traveling expenses	687.57	80.27
Buildings and land	7.56	351.44
Totals	$15,000.00	$15,000.00

SUPPLEMENTARY STATEMENT OF FUNDS RECEIVED FROM OTHER SOURCES THAN THE UNITED STATES.

FOR THE FISCAL YEAR ENDING JUNE 30, 1921.

DR.	Sales	Miscellaneous	Total
To balance on hand	$1,142.88	$172.23	$1,315.11
Receipts from other sources than the United States for the year ended	2,654.78	15,970.42	18,625.20
Totals	$3,797.66	$16,142.65	$19,940.31
CR.			
By Salaries	$.....	$3,823.00	$3,823.00
Labor	1,137.03	3,288.70	4,425.73
Publications	.....	61.61	61.61
Postage and stationery	.....	154.94	154.94
Freight and express	17.79	114.22	132.01
Heat, light, water and power	.....	18.15	18.15
Chemicals and lab. supplies.	46.91	391.27	438.18
Seeds, plants, and sundry supplies	739.90	4,912.30	5,652.20
Fertilizers	355.61	49.14	404.75
Feeding stuffs	578.28	149.18	727.46
Library	.....	51.19	51.19
Tools, machinery, and appliances	10.00	322.47	332.47
Furniture and fixtures	2.50	.....	2.50
Scientific apparatus and specimens	545.97	418.20	964.17
Live stock	.....	150.00	150.00
Traveling expenses	10.00	971.09	981.09
Contingent expenses	.....	33.75	33.75
Buildings and land	111.64	259.55	371.19
Balance	242.03	973.89	1,215.92
Totals	$3,797.66	$16,142.65	$19,940.31